New Mars rover tool will zap rocks to investigate planet's past habitability

July 27, 2020

LOS ALAMOS, N.M., July 27, 2020—When NASA's Perseverance rover launches from Florida on its way to Mars, it will carry aboard what is likely the most versatile instrument ever made to better understand the Red Planet's past habitability.

"SuperCam is often referred to as the 'Swiss Army Knife' of instruments because it's a multipurpose tool in a small package," said Roger Wiens, the lead scientist on SuperCam at Los Alamos National Laboratory, where the instrument was developed.

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Meet the new Mars 2020 Rover: Perseverance

SuperCam sits on the rover's mast and is equipped with a laser that can zap rocks up to 25 feet away, allowing Perseverance to study rock samples that can't be reached with its robotic arm. "The laser's dot is smaller than a pencil point and examines rock textures and chemicals to find those that formed or changed in water on Mars long ago, which can tell us about past habitability of the planet. It also looks for rocks and soils that could preserve signs of past microbial life, if any existed," said Wiens. Furthermore, SuperCam will help identify elements in the martian dust that might be harmful to humans, which is critical information for future human exploration of the planet.

SuperCam will also feature the first scientific microphone to ever operate on Mars. It will listen to the snap of the laser impacts to tell how hard the rocks are. This will provide another important piece of information for geologists to understand what the rocks are telling us about Mars' past. In addition, the microphone can be used to determine the wind speed and direction, and can measure the speed of sound for the first time on another planet. The microphone will provide the first-ever recordings from the martian surface, which, as Wiens, said, "is just really cool."

SuperCam is the next-generation version of ChemCam, which is another instrument that sports a rock-zapping laser and is currently aboard NASA's Curiosity rover traversing Mars. While Curiosity's ChemCam uses one laser technique, SuperCam will use several. ChemCam uses an infrared-colored laser beam, which heats rock fragments to around 18,000 degrees Fahrenheit (10,000 degrees Celsius), vaporizing them. SuperCam can additionally modify this beam to a green color to make organic materials and certain minerals fluoresce, or glow. The vaporization method is called Laser Induced Breakdown Spectroscopy, or LIBS; the green-laser method is called time-resolved Raman and luminescence spectroscopy.

The Raman and luminescence spectroscopy method pairs the laser with an incredibly fast shutter on SuperCam's light sensor. The shutter can open and close in as short as 100 nanoseconds—so fast that almost no daylight will enter it. Minerals fluoresce at different rates, which can be detected when slowing the shutter speed or delaying the exposure relative to the laser pulse. SuperCam can also use visible and infrared light from the Sun to look for clay, sulfate, or carbonate minerals in rocks.

In addition to SuperCam, the SHERLOC instrument on the arm of the rover will use UV laser-induced fluorescence to search for organic molecules that might be signs of life. SHERLOC claims ChemCam heritage, specifically for its detector and electronics, which were built in Los Alamos.

"We've learned an immense amount about Mars over the last decade while the Curiosity rover has trekked across the planet's surface," said Wiens. "We now know that lakes, rivers, streams, and likely oceans were part of the geologic history of Mars—which begs the question: if water once existed on Mars, did life also exist there? The Perseverance mission hopes to answer that question."

SuperCam was designed and built by an international team of more than 300 people. The effort is led by Los Alamos National Laboratory in New Mexico, where the instrument's body unit was developed. That part of the instrument includes several spectrometers, control electronics, and software. The mast unit was built with contributions from numerous academic laboratories in France, led by the French space agency Centre National d'Études Spatiales, and includes the high-powered laser, a telescope, a camera, an infrared spectrometer, and a microphone. Calibration targets on the rover deck are provided by Spain's University of Valladolid. JPL built the rover and will manage its operations for the NASA Science Mission Directorate at the agency's headquarters in Washington.

An artist's rendering of NASA's Mars 2020 Perseverance rover. Credit: NASA/JPL-Caltech